


<TITLE PAGE HEADER>Journal of Building Survey, Appraisal & Valuation Volume 3 Number 4

<RIGHT RH> Hardi and Pittard

<VERSO RH> BIM implementation

<TITLE> **If BIM is the solution, what's the problem? A review of the benefits, challenges and key drivers in BIM implementation within the UK construction industry**

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<RECEIVED DATE>

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ABSTRACT

The interest in Building Information Modelling has increased within the construction industry over the past few years, both within the UK and globally. This interest was accelerated in 2011, following the UK Government's announcement that BIM would be mandated on all UK centrally procured public sector projects by 2016. BIM has been described as a game-changing Information Communication Technology and cultural process for the construction sector. This paper provides an overview of BIM. It also outlines the benefits, challenges and the key drivers in BIM implementation within the UK construction industry. Findings from this paper indicate that a shift towards collaborative working within the construction industry is crucial to ensure that BIM is implemented fully and for its benefits to be wholly realised.

Keywords: multi-disciplinary, Building Information Modelling (BIM), Information Communication Technology (ICT), efficiency, collaborative working, benefits of BIM, collaboration

INTRODUCTION

Background to the problem

The UK construction industry is characterised by the embedded attributes of fragmentation and silo working. These attributes have been the achilles heel of an industry in which miscommunication and defects have been all too readily accepted despite a number of reports[7, 15] highlighting the need for change.

The Latham report[11] described the UK construction industry as 'ineffective', 'adversarial', 'fragmented', and 'incapable of delivering for its customers', and the Egan report[7] suggested the need to push for integrated project processes to tackle this problem. Following the publication of the Latham and Egan Reports, it became clear that clients and their suppliers would need to work together on a shared improvement plan to achieve a more efficient delivery in the construction industry.

While the design process must be flexible enough to accommodate the needs and requirements of the client, unnecessary changes through a lack of co-ordination are likely to result in unavoidable delays and/or increased costs — arguably the main cause of the industry's historically poor performance.

As good communication is key to project success, the industry will need to move away from its traditional silo mindset to embrace a more collaborative approach to project delivery. Promoting information sharing is part of this collaborative approach and it essentially forms the principles of Building Information Modelling (BIM).

So what does BIM really mean?

BIM has generated significant interest and debate, both within the UK and globally. In the UK specifically, there has been a push by the UK Government for the construction industry to implement BIM with the aim of driving efficiencies throughout all aspects of the asset delivery lifecycle, targeting reductions in cost, risk, carbon emission and time.

BIM requires a move away from the traditional workflow, with all parties sharing, and effectively working on, a common information pool — creating a single version of the truth. BIM changes the emphasis by making the model the primary tool for information, from which an increasing number of documents, or more accurately 'reports', such as plans, schedules and bills of quantities may be derived. The primary asset of a BIM is the *information*.

Often (mistakenly) referred to as 3D, 4D or any dimension (nD), BIM should not be confused with the number of dimensions used to represent a building or asset. At its simplest level, BIM provides a common data environment (CDE) for all information defining a building, facility or asset, together with its common parts and activities.

BIM has been described as a game-changing ICT (Information Communication Technology) and cultural process for the construction sector. While the concept of BIM may have its roots in 2D digital drawings and product modelling,[10] it has since developed to provide a shared project information model, allowing integration with other aspects of project delivery, including cost and time. This collaborative approach to project delivery becomes progressively more important for large complex projects where the number of stakeholder interfaces (and potential failure points) is often significantly increased.

BIM is sometimes (mistakenly) thought to be just a new version of CAD (Computer Aided Design) due to its technology-centric concept.[8] However, BIM is more than just 3D CAD. BIM combines technology with new working practices to improve the quality of the delivered product and the reliability, timeliness and consistency of the process. The aim is to draw the project stakeholders together earlier so that the individual parties can co-ordinate their input, encouraging a more integrated approach to project delivery.

Why now?

As already indicated, BIM is not a new subject within the UK construction industry. It has evolved and is now seen by many as the catalyst for change, delivering the much needed improvements in efficiency and working practices.

The effects of the worst economic recession in living memory have accelerated the need for change, and BIM offers an attractive solution to a cash-strapped government seeking to deliver 'more for less'. In addition to this, the Government's Plan for Growth, published alongside the

budget in 2011, highlighted the critical importance of an efficient construction industry to the UK.[5] BIM offers the means to increase productivity and efficiency, not only during the design and construction stages, but, perhaps even more significantly, during the operational life of an asset.

The UK Government has raised the importance of BIM compliance within the construction industry over the past few years. BIM has developed in the UK market following the announcement in the UK Government's Construction Strategy in 2011 that BIM will be mandated on all UK centrally procured public sector projects by 2016.[5]

In 2013, the UK Government also published its Industrial Strategy report,[9] which stated that part of the vision for the year 2025 is the provision of an industry that is efficient and technologically advanced, with BIM as one of its objectives to support the delivery of this aim.

THE STRUCTURE OF BIM

The 'Strategy paper for the Government Construction Client Group' divided BIM into various levels of maturity.[1] Figure 1 below shows the BIM maturity levels in greater detail.

<INSERT FIG 1>

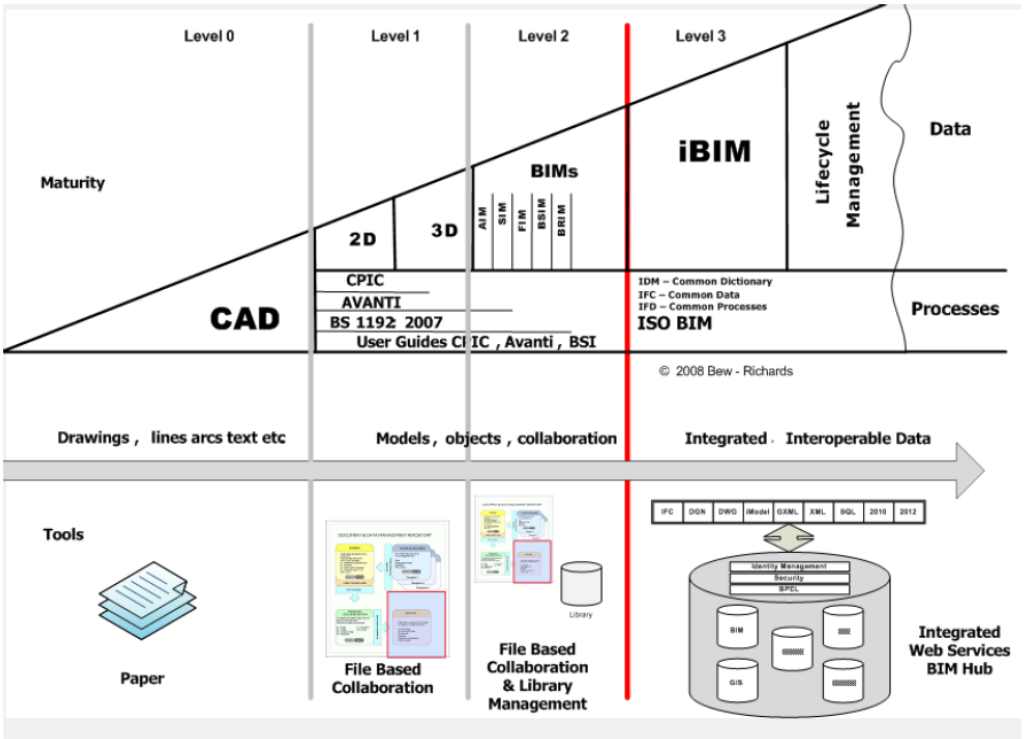

Figure 1: BIM maturity chart (taken from PAS 1192-2:2013)[3]

<END FIG 1>

The definitions of these levels of maturity is outlined below:

<INSERT TABLE 1>

BIM Maturity Level	
Level 0	Data exchange process is in the form of unmanaged CAD and the use of only 2D design application.
Level 1	Data exchange process is in the form of managed 2D and 3D CAD with a collaborative tool embedded to provide a common data environment and a standardised approach to data structure and format. Finance and cost management are not integrated and managed separately.
Level 2	Data exchange process is in the form of a managed common data environment (CDE). It may utilise construction sequencing (with timeline and workflow attached to it) and/or cost information.
Level 3	A fully integrated and collaborative process enabled by online network/web services. It is to be compliant with the Industry Foundation Class (IFC). This level utilises cost, time and other information to support the project delivery lifecycle.

Table 1: BIM maturity level (reproduced from PAS 1192-2:2013)[3]

<END TABLE 1>

The definition for Level 2 BIM was further refined in 2014 by the UK Government. It consists of seven specification components for information management:[4]

<LIST>

1 **PAS 1192-2:2013:** for the capital/delivery phase of the construction projects.

2 **PAS 1192-3: 2014:** for the operational phase of assets.

3 **PAS 1192-4:** collaborative production of information. Part 4: fulfilling employers' information exchange requirements using the COBie (Construction Operations Building Information Exchange) Code of Practice.[17]

4 **Construction Industry Council (CIC) Building Information Model (BIM) Protocol:** was published by the CIC in February 2013 and can be used to amend a scope of services/specification and thereby incorporate specific obligations, liabilities and associated limitations on the use of those models — as part of the contract.[6]

5 **Government Soft Landings (GSL)**: a handover process in which the project team is contracted to monitor the building, support the occupants and fine-tune the building's systems for up to 3 years post-completion.

6 **Digital Plan of Work (DPoW):** an industry standard method of describing geometric, requirements and data deliveries at key stages of the project cycle.

7 **Classification:** a structured and standardised information classification system.

<END LIST>

WHERE ARE WE ON THE BIM JOURNEY?

The implementation of BIM is still at a relatively early stage in its evolution. While there has been much interest in the form of initiatives to implement BIM within the construction industry, many are still at pilot stage. As there is no general centralised database publishing the number of projects completed under BIM it is difficult to ascertain the rate and number of projects meeting Level 2 compliance. Indeed, although some may already be talking about Level 3, there is certainly little evidence to suggest that the industry has progressed beyond Level 2. Some exemplary BIM projects worth noting are as follows:

Ministry of Justice: HMYOI Cookham Wood in Rochester, Kent[2]

This was one of the early adopter projects. Commenced in 2012, the project comprised the provision of a new 179-room accommodation block and a new associated education facility for the Youth Justice Board. The project was implemented using COBie as the common data exchange medium (to allow data to be fed from the BIM model into the Estate Facilities Management programme), 3D CAD, automated clash detection, performance measurement, construction sequencing, an integrated cost plan and GSL. The outcome of this project suggests that:

<EXTRACT>

- The 3D model enabled the building design and its eventual operation to be more clearly illustrated.
- Early project scoping and stakeholder engagement, aided by the use of the BIM model as a visual tool, has contributed towards considerable financial savings and improved handover (GSL).
- Accessing all project information from a single combined model significantly reduces scope for error.
- Many of the benefits of BIM in design are realised during the construction phase in experiencing fewer issues on site, ultimately reducing timescales, abortive work and cost.

<END EXTRACT>

Procure21+

The ProCure21+ National Framework is a framework agreement with six supply chains, known as Principal Supply Chain Partners (PSCPs), selected via an OJEU (Official Journal of the European Union) tender process for capital investment construction schemes across England up to 2016.[14] All NHS clients who use Procure21+ are required to achieve Level 2 BIM compliance on all of their

projects. Leighton Hospital, an example of a project which has implemented a Procure 21+ and BIM process, suggests that:

<EXTRACT>

- Risk has been reduced through fully co-ordinated M&E services with the structure.
- Clash avoidance has been identified off site, hence avoiding costly remedial works on site.
- The use of clash avoidance within the BIM model has allowed off site fabrication to be better controlled.
- There was effective communication between contractor and client as the BIM model contained a rich source of information for users.
- There was reduced maintenance cost due to easy access to relevant and up-to-date information held within the soft landing and BIM data.

<END EXTRACT>

WHAT ARE THE CHALLENGES IN IMPLEMENTING BIM?

The push by the UK Government to implement BIM Level 2 in all public sector projects by 2016 has received a mixed reaction from the construction industry. Some feel that this is an unachievable goal, whereas others embrace the change in the process. The main challenges in BIM implementation include:

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- The *conservative* attitude among professionals in the construction industry, meaning that many are unwilling to make changes due to lack of knowledge and interest in BIM.
- The perceived cost of obtaining the technology (hardware and software cost investment). The challenge is in justifying and convincing others of the expenditure. The NBS 2012 report[13] suggests that adopting BIM can cost a practice £10,000 per workstation. However, it is important to note that this depends on whether the implementation is simply an exercise in buying hardware and software and then training staff to use it, or whether it is part of a wider process of business change.
- Due to the lack of maturity, there is limited knowledge and experience among professionals in the construction industry. This contributes to the challenge in implementing BIM.

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WHAT DO WE NEED TO MAKE BIM HAPPEN?

There is no quick fix to make BIM happen. The main priority, however, is to raise awareness within the construction industry so that professionals understand that BIM is more than just a 3D CAD and clash detection. It is about collaborative working, integrating process, people and technology, with information as the output.

A strategic objective has been set to achieve Level 2 compliance. PAS 1192-2:2013 defines this by specifying the requirements for collaborative working and information management, whereas PAS 1192-3:2014 offers guidance on the use and maintenance of asset information model (AIM) to support operational use of the asset.

While we have seen some process improvement through these and other new standards, protocols and resources, the need for cultural change and a shift from a silo mentality to collaborative working remains the biggest challenge — emphasising the need for education and training.

BIM MOVING FORWARD

In 2012, the Business Innovation Skills Building Information Modelling (BIS BIM) Task Group developed a Digital Plan of Work (dPOW) intended to establish the uniform and consistent development of information throughout the lifecycle of an asset — irrespective of the construction sector. Figure 2 below, created by the BIM Task Group provides a summary of the dPOW work stages.

<INSERT FIG 2>

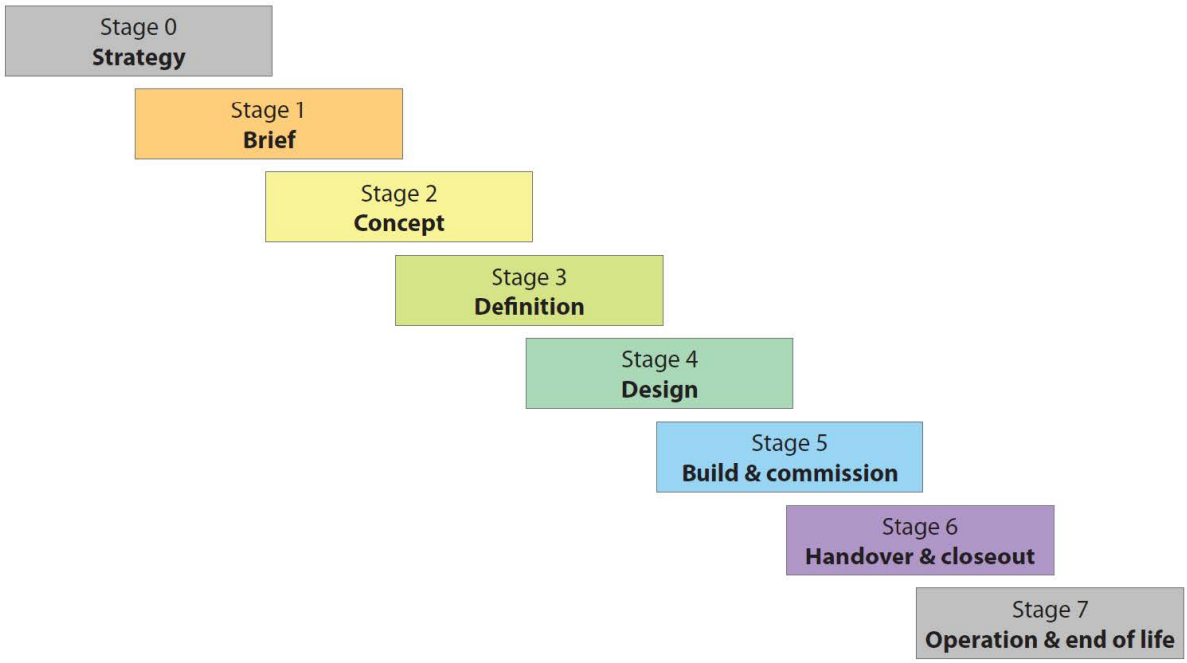

Figure 2: The BIM Task Group's Digital Plan of Work

<END FIG 2>

BIM encourages design, construction and operation based on a 'single version of the truth', where data is consistent and in a non-redundant form, without ambiguity and managed in a CDE.

In essence, BIM involves building a digital prototype of the model and simulating it in a digital world — coining the phrase 'build before you build'. It enables the project stakeholders to share and co-ordinate design information to avoid clashes during construction. It is, therefore, essential that the industry learns to use structured and shareable data throughout all phases of the delivery process. BIM also relies on the adoption of standard industry classification in which components can be communicated more easily between the supply chain and client. For BIM to succeed it needs:

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- a common language;
- a platform to communicate the common language;
- a willingness to communicate the common language.

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There are three ways to apply BIM communication protocols:[12]

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- bespoke: where everyone learns everyone else's language;
- single platform (closed BIM): where everyone changes their language to one common language;
- common platform (open BIM): where everyone uses their own language with a common interpreter.

<END LIST>

Common Platform (open BIM) would appear to offer the preferred approach as it encourages the use of open standards rather than any particular proprietary exchange format. A successful BIM will need to have a defined data exchange format. COBie provides the interim step towards Industry Foundation Classes (IFC) for the whole lifecycle management of the asset. COBie provides the interface within the BIM process where reusable data from COBie is the output. Adopting a unified and common data delivery platform is desirable because:

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- 80 per cent of the lifecycle cost lies beyond construction;
- asset information is currently very poor;
- a 5 per cent saving in operational expenditure will achieve the UK Government's initial target of a 20 per cent saving in capital expenditure;
- it will enable operators to better manage their assets.

<END LIST>

BIM is a game changer. The question is: can we play by the new rules? For BIM to be successful the construction industry must understand and embrace collaborative working with the support of data information, technology and process/standards.

CONCLUSION

BIM is more than just 3D CAD, it is a process and a way of working supported by digital technologies to improve building/infrastructure efficiency throughout the lifecycle of an asset. To ensure that BIM is implemented effectively, the UK construction industry will need to move away from a silo working culture, embracing a collaborative working approach to project delivery. It is also crucial for professionals within the construction industry to be aware of what BIM actually means, what it does and doesn't do.

Due to the lack of maturity, there is currently limited BIM knowledge and experience within the construction industry. It is, therefore, essential that any learning output from pilot projects or case studies are widely disseminated so that the construction industry is better placed to adopt challenges and the collaborative working practices required to achieve the UK Government's target by 2016.

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(17) COBie is a performance-based specification for facility asset information delivery. The two types of assets included in COBie are: equipment and spaced. Its aim is to help project teams organise electronic data approved during design and construction. It is also used to deliver a consolidated electronic Operational and Maintenance (O&M) manual. The data can be imported into any asset management software.